Cushing Infrastructure, Prices, and Quality

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**Genscape Coverage**

**100% Cushing Storage:**
Flight crews fly each facility on a twice-weekly basis to gather visual and infrared imagery of each tank.

**93% Cushing-Connected Pipeline Capacity:**
Pumping station power consumption is measured via patented remote sensor every 30 minutes.

**100% Cushing-Connected Rail:**
Fixed visual cameras are used to count rail car deliveries daily.

**100% Cushing-Connected Refineries:**
Remote infrared cameras pointed at refineries send images every 5 minutes.

*Source: Genscape*
The Cushing storage hub and Cushing-connected pipeline infrastructure have grown larger and more complex.

What is now a combined >7mn bpd (capacity) pipeline infrastructure system requires evolving and nuanced information and understanding.

Similarly, the Storage hub has grown from >25 mn bbls to >94 mn bbls (capacity).
Cushing Pipelines: Then and Now

Cushing Pipeline and Refinery Connectivity 2012

Cushing Pipeline and Refinery Connectivity

Incoming Pipelines (mbpd)
- 0 - 250
- 250 - 500
- 500 - 1,200

Outgoing Pipelines (mbpd)
- 0 - 250
- 250 - 500
- 500 - 1,200

Connected Refineries

Storage Hub

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Cushing Storage: Then and Now

Source: Genscape

May 2012

May 2019
## Cushing Pipeline Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Owner</th>
<th>Origin</th>
<th>Destination</th>
<th>In-Service Date</th>
<th>Add’l Capacity (bpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red River Expansion</td>
<td>PAA/Delek</td>
<td>Cushing, OK</td>
<td>Longview, TX</td>
<td>1H 2020</td>
<td>85,000</td>
</tr>
<tr>
<td>Gladiator</td>
<td>SemGroup/DCP</td>
<td>Cushing, OK</td>
<td>Houston, TX</td>
<td>3Q 2020</td>
<td>300,000</td>
</tr>
<tr>
<td>Diamond Expansion</td>
<td>PAA</td>
<td>Cushing, OK</td>
<td>Memphis, TN/Capline</td>
<td>3Q 2020</td>
<td>200,000</td>
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<tr>
<td>Voyager</td>
<td>Magellan/Navigator</td>
<td>Cushing, OK</td>
<td>Houston, TX</td>
<td>4Q 2020</td>
<td>250,000</td>
</tr>
<tr>
<td>Red Oak</td>
<td>Phillips 66/Bridger</td>
<td>Cushing, OK</td>
<td>Corpus Christi, Houston &amp; Beaumont, TX</td>
<td>4Q 2020</td>
<td>400,000</td>
</tr>
<tr>
<td>Seahorse</td>
<td>Tallgrass</td>
<td>Cushing, OK</td>
<td>St. James and Plaquemine, LA 3Q 2021</td>
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<tr>
<td>Marketlink Expansion</td>
<td>TC Energy</td>
<td>Cushing, OK</td>
<td>Houston &amp; Beaumont, TX</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

**Cushing-Connected Pipeline Capacity (mn bpd)**

[Source: Genscape]
Cushing Inventories and Price Changes
Cushing Inventories Fall to Near-Record Low

- Substantial draws coincided with a switch in WTI futures contracts to a backwardation structure, as has been observed in the past.
- Cushing inventories plummeted more than 41mn bbls between early November 2017 and mid-September 2018, despite builds during Spring refinery maintenance season.
- Storage capacity utilization fell to 30% in mid-September 2018, near the historical low of 27.8%.

Source: Genscape
Cushing Stocks Higher after Fall 2018 Refinery Maintenance Season, Pipeline Changes

- Stocks in Cushing increased more than 12.5mn bbls to 37.8mn bbls between weeks ending Sept. 14 and Nov. 9, 2018, coinciding with the fall refinery turnaround season.
- Cushing inventories posted the first weekly draw in two months during week ending Nov. 16, 2018.
- However, the building pattern then resumed, with stocks increasing 12.3mn bbls between weeks ending Nov. 16, 2018 and March 1, 2019, reaching the highest level since January 2018.
- Part of the increase was due to the Sunrise/Basin expansion and Keystone leak.
- Due to unfavorable economics, flows from the Permian into Cushing reduced in March 2019, contributing to a 2.3mn bbls draw March 1-19, 2019.

Source: Genscape
Keystone Leak

- Flows on Keystone pipeline effectively shut from 622,000 bpd around 9:30 a.m. (ET) on Feb. 6. The line operated below normal levels for more than 12 hours before volumes ramped back up.

- Keystone shut following a leak near St. Louis, MO, on the Steele City-to-Patoka, IL, segment of the line. The line to Patoka effectively shut around the same time as the trunkline from Hardisty. Keystone flows to Cushing, OK, increased sharply in the days following the outage.

- Cushing inventories increased 4.8mn bbls Feb. 5-22, while flow was predominately directed to Cushing.

- WCS prices weakened considerably on Feb. 7 as news circulated of the Keystone outage, according to several sources. Genscape alerted on the restart of Keystone early Feb. 7, creating opportunities for Genscape customers who had greater insight on the impact of the outage than market participants who still believed Keystone to be shut. WTI prices fell $0.40/bbl in the hour following Genscape’s Keystone restart alert.

- Flows on the Patoka leg were shut for ~14 days resuming on Feb. 19.
Tariff rates for uncommitted shippers on Basin and Midland-to-Sealy are $0.80/bbl and $7.04/bbl, respectively, according to Plains and Enterprise.

Source: Genscape
Lower Basin Flows Lessened Takeaway from West Texas

Flows on the 550,000 bpd Wichita Falls, TX,-to-Oklahoma segment of Plains All Americans' 550,000 bpd Basin pipeline plummeted 156,000 bpd to 362,000 bpd for week ending March 15.

Flows on Basin averaged less than 300,000 bpd for each day between March 13 and March 19.

Flows decreased amid shifting transportation economics. The spread did not widen past WTI-Cushing minus $0.70/bbl once between late January and late March, eliminating profitability for spot shippers.

Crude inventories at monitored terminals in West Texas climbed 693,000 bbls to 16.266mn bbls week ending March 15, rising to the highest level since early February. The largest build of 583,000 bbls took place at Wichita Falls, coinciding with the lower Basin takeaway.

Decreased flows also contributed to a 1.446mn-bbl draw in Cushing between March 12 and March 15. Front month WTI-Cushing prices increased $0.50/bbl to $59.19/bbl within an hour following Genscape's March 18 publication of the storage draw.
Cushing-Connected Refineries: Spring 2019 TARs/Outages

January 2019
- P66 – Wood River CDU TAR

February 2019
- P66 – Wood River CDU TAR/Fire
- P66 – Ponca City CDU TAR
- HollyFrontier – Tulsa CDU TAR

March 2019
- P66 – Wood River CDU TAR/Fire
- HollyFrontier – Tulsa CDU TAR
- CVR – Wynnewood CDU TAR
- CHS – McPherson CDU TAR
- HollyFrontier – El Dorado Refinery Fire

April 2019
- CHS – McPherson CDU TAR
- BP – Whiting CDU TAR
- P66 – Borger FCC TAR

May 2019
- BP – Whiting CDU TAR
- Valero – Memphis FCC TAR/CDU outage
- HollyFrontier – Tulsa Refinery Flooding

Primary Processing Utilization

Source: Genscape
Cushing Stocks Increase 2mn bbls

Crude inventories in Cushing, OK, jumped 2.028mn bbls to 48.443mn bbls for week ending May 3, marking the largest weekly build since late February. Lower outbound pipeline flows and regional refinery maintenance heavily contributed to the storage build.

The majority of the weekly increase took place during the beginning of the week, as stocks climbed 1.955mn bbls between April 26 and April 30. The increase marked the largest mid-week build since March 2018 and brought storage levels to the highest level since early April.

NYMEX Light Sweet Crude (WTI) front month prices fell $0.38/bbl to $61.69/bbl within the first 10 minutes of Genscape’s May 2 Cushing storage report. Prices continued decreasing to a daily low of $60.98/bbl within the next two hours, down $1.09/bbl from the Cushing data publication.
Cushing Inventories Top 50mn bbls for First Time Since 2017

- Inventories in Cushing, OK, increased 1.219mn bbls to 50.981mn bbls for week ending May 17, crossing the 50mn-bbl threshold for the first time since December 2017. Stocks climbed 4.829mn bbls across the past five weeks after falling 3.808mn bbls during the previous six weeks. Overall capacity utilization at the hub climbed to 58%.
- Lower outbound pipeline flows to destinations in the Midwest and the Gulf Coast contributed to Cushing storage builds in May. Utilization on lines to the Midwest decreased 15 percentage points to 71% between weeks ending April 12 and May 17 as refinery maintenance led to decreased demand. Primary processing utilization at monitored PADD 2 refineries decreased 13 percentage points to 85% during the same time period. Meanwhile, utilization on Cushing-to-Gulf Coast pipelines averaged 99 percent for week ending May 17.

Source: Genscape
The cost to store at Cushing was approximately $0.41/bbl/month in mid-March, according to the Tank Tiger.
Cushing Quality
Cushing Incoming Pipeline Capacity

**West TX to Cushing**
- Basin
- Centurion North

**Canada to Cushing**
- Keystone
- Spearhead
- Flanagan South
- Hawthorn

**MW and Rockies to Cushing**
- White Cliffs
- Cashion
- Hawthorn
- OK Mainline Sys
- Medford Plains LPG
- Northern Cimarron
- Great Salt Plains
- Eagle North
- Mississippian Lime
- Glass Mountain
- Pony Express
- Magellan Scoop
- Saddlehorn
- Red River

Source: Genscape
Cushing Incoming Pipeline Utilization

Source: Genscape